

IDAHO

DEPARTMENT OF FISH AND GAME

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SMOLT COLLECTION AND TRANSPORTATION AT
LOWER GRANITE DAM ON THE SNAKE RIVER, 1987

Submitted to

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by

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INTRODUCTION

The Corps of Engineers (COE) and Idaho Department of Fish and Game (IDFG) entered into a cooperative agreement (Contract No. DACW 68-82-C-0054) with task orders for the 1987 smolt collection and transportation operation at Lower Granite Dam. An IDFG state biologist was detailed to assist COE biologists with collection, evaluation of condition, and transportation of outmigrating steelhead and chinook smolts.

Responsibilities of the IDFG state biologist were as follows: (1) daily sampling for species composition and weight estimation; (2) estimates of descaling rates; (3) determination of the percent of total facility collection that must be sampled to accurately estimate species composition and weight; (4) routine inspections of the operation and maintenance of collection and transport facilities directly affecting the welfare of collected smolts; (5) maintaining records of fish count data by species including daily and cumulative counts and their relationships to river flows; (6) monitoring research activities of University of Idaho and National Marine Fisheries Service; and (7) preparation of weekly summary reports of the juvenile fish collection and transportation program activities.

RIVER CONDITIONS

Water temperatures of the Snake River at Lower Granite Dam ranged from 44°F on March 26 to a high of 72°F on July 13. On July 31, when transportation was terminated, the river temperature was 69°F. During June and July, rain and cooler than normal weather caused periodic fluctuations in river temperatures, resulting in lower than anticipated water temperatures related to the 1987 drought conditions.

Because of the low flows experienced at Lower Granite Dam, trash accumulation in the forebay was below normal. Small amounts observed had little effect on the operation of the smolt collection facility.

Low flows and drought conditions stalled migrating smolts in the Lower Granite pool. Flash flooding of the Clearwater River during late April triggered conditions that pushed large numbers of fish into the collection facility. As a result, record numbers of fish were collected on seven consecutive days, the highest being 486,452 on May 2 (Appendix 1). The previous record was set in 1981 with a 24-hour collection total of 255,003.

Flows never exceeded 100 kcfs at Lower Granite Dam in 1987 (Table 1). Low snowpack and lack of spring rains decreased the flow considerably from 1986. Snake River flows fluctuated between 16.1 and 99.3 kcfs from March 25 until July 31. Peak flow in the Snake River was reached on May 1 and was recorded at 99.3 kcfs. The season's highest flows were a direct result of water budget releases, and spill was nonexistent at Lower Granite Dam in 1987.

Table 1. Mean daily flows at Lower Granite Dam during 1987 outmigration.

Date	March	April	May	June	July
01		25.5	99.3	43.1	19.4
02		25.5	90.0	40.1	18.8
03		28.1	77.0	36.3	18.9
04		28.5	73.2	34.6	18.5
05		29.8	70.2	32.0	18.8
06		30.6	74.0	31.7	16.1
07		37.0	94.7	31.2	17.2
08		37.8	95.3	29.5	19.6
09		38.4	72.6	28.6	22.0
10		37.1	69.1	30.4	19.1
11		37.6	68.3	32.0	18.9
12		37.4	94.9	31.6	19.1
13		35.6	97.5	31.9	17.5
14		32.7	97.0	28.8	19.8
15		32.4	80.2	28.9	22.2
16		35.6	79.9	29.5	19.1
17		41.4	77.6	28.0	16.6
18		45.4	69.3	28.8	17.6
19		42.4	50.1	30.7	17.7
20		38.4	49.3	30.5	18.7
21		39.2	42.2	28.1	20.8
22		37.9	37.5	25.6	20.3
23		39.3	35.5	29.9	25.7
24		47.7	34.1	29.6	26.1
25	34.5	51.5	32.3	24.8	28.3
26	30.3	52.9	34.7	23.8	27.5
27	32.0	54.5	36.2	23.7	25.6
28	32.7	72.5	38.9	20.0	22.5
29	27.4	86.3	37.3	19.7	17.2
30	27.8	91.5	35.1	20.0	18.0
31	25.6		35.1		
Average	30.04	42.35	63.82	29.45	

FISH COLLECTION

In 1987, a new fish collection record was established at Lower Granite Dam. Low flows and a nonexistent spill caused all migrants to go through the powerhouse. From March 26 through July 31, a total of 5,512,434 fish were collected. Species composition included 2,497,635 chinook salmon, 2,463,039 hatchery steelhead trout, 550,947 wild steelhead trout, 791 sockeye salmon, and 22 coho salmon (Appendix 1).

The species and number of fish collected at Lower Granite Dam are related to release sites, dates of release, and river flows. Chinook smolts dominated the early part of the run, peaking on April 27 with 182,878 smolts collected. Three days later, steelhead smolts dominated the collection with 150,774 smolts collected (76.82 hatchery). Steelhead peaked on May 2 when 306,076 fish were collected (78% hatchery). As previously reported, May 2 was also the record daily collection for the Lower Granite project with 486,452 smolts collected.

JUVENILE SAMPLING

Daily sampling began at Lower Granite Dam on March 26 and continued until July 31. The total number of fish sampled during this period was 323,243. Numbers and species of sampled fish were: 137,539 chinook, 153,709 hatchery steelhead, 31,941 wild steelhead, 54 sockeye, and 2 coho.

Fish were sampled each day to: (1) determine species composition; (2) determine the number of fish per pound by species; (3) determine length frequencies; (4) assess fish health and descaling rates; and (5) establish accurate estimates of total collection numbers. Additionally, NMFS checked all sample fish for freeze-brands and marked sample fish for fish transportation evaluation studies.

Operations in the sample room ran smoothly with little sign of mortality or stress. New water chillers were installed to minimize temperature fluctuations between the river and the sorting trough. The system was always watered up prior to sampling in order to temper the system for that particular day's temperature.

Sampling operations functioned well in 1987. The incidence of "knifed" fish experienced in 1986 was kept to a low level in 1987 by careful operation of the 18-inch knifegates. During 1986, fish were often found in the sorting trough after the day's sample was completed. This year, extra flushing of the semitransparent sample line eliminated fish from holding in the low velocity areas and allowed workers to check for stranded fish at the end of the sampling day.

Fish used in calculating daily pound counts frequently jumped out of the buckets while being transported to the holding tank outside of the sample room. Electric fish crowders worked very well throughout the 1987 season. Minor problems arose when the wheel tracks were not cleaned and greased, causing the crowder to jam and break shear pins on the drive rod.

Daily collection sample rates ranged from 1.67% to 25% (Table 2). Sample rates varied depending on expected daily collection, marking needs, and projected sample tank densities. After sampling, fish were loaded onto a barge or truck or diverted to a holding tank outside of the sampling room.

Electronic fish counters enumerated fish entering the sample tank with improved accuracy this year. The accumulated total number of sample fish was 98.03% of the accumulated counter total.

TRUCK TRANSPORTATION

A total of 43 truckloads of fish were transported from Lower Granite Dam during 1987. Fall transport trucks hauled 281,969 fish, approximately 5.15% of the total transportation effort (Appendix 2). Following is a breakdown of species and numbers: chinook 56,931 (20.2%), hatchery steelhead 201,574 (71.5%), wild steelhead 23,430 (8.3%), and sockeye 34 (0.01%).

Trucking began on March 29 and continued as needed until April 6. After April 6, fish collection numbers had increased beyond trucking capacity, and barge transportation began. Early season trucks transported 3,271 fish (1.2%). Chinook, hatchery steelhead, wild steelhead, and sockeye accounted for 2,544 (77.7%), 265 (8.1%), 441 (13.5%), and 21 (0.7%), respectively.

Late season trucking began on June 5 and transported fish each day until June 20. Additionally, 2 truckloads of fish were transported on June 16 and July 3 and 5. After June 20, trucks transported fish every other day until the juvenile collection facility was shut down on July 31. Late season trucks transported 278,698 fish (98.8%). Chinook, hatchery steelhead, wild steelhead and sockeye accounted for 54,387 (19.51%), 201,309 (72.23%), 22,989 (8.25%), and 13 (0.01%), respectively.

On June 8, a truck refrigeration unit malfunctioned in route to the release site below Bonneville Dam. Tank temperatures had reached 69°F at the time of release, resulting in a mortality of 600 to 700 fish.

Table 2. Daily juvenile collection sample rates at Lower Granite Dam, 1987.

Date	March	April	May	June	July
1		9	3	9	9
2		9	3.835	9	9
3		9	1.67	9	9
4		9	2.55	9	9
5		9	4.46	9	9
6		9	5.944	9	9
7		9	11.25	9	9
8		7.5	9.75	9	9
9		6	9	9	9
10		9	3	9	9
11		9	11.5	9	9
12		6	14.87	9	9
13		6	11.5	9	9
14		12	12	9	9
15		4.625	9	7	9
16		15	3	6	9
17		3	3	8.125	9
18		15	12	9	9
19		3.75	3	9	9
20		9	14.5	11.625	11.75
21		3	3	9.375	9
22		6	20.83	9	9
23		3	9	9	9
24		9.305	9	9	9
25		3	20.66	9	9
26	9	6	9	9	9
27	9	1.89	25	9	9
28	9	5.625	9	9	9
29	9	3	9	9	9
30	9	3.97	9	9	9
31	9	-	9	-	9
Average	9	7.122	9.075	8.904	9.089

Sample rates in % of total daily collection.

BARGE TRANSPORTATION

In 1987, barges made 42 trips from Lower Granite Dam to the release site below Bonneville Dam (Appendix 3). Barges began transporting fish every other day beginning on April 10. On April 26, fish collection numbers had increased, requiring barges to run every day. Everyday barging operations continued until May 23, when barges departed every other day due to declining collection numbers. On June 4, 1987, the final barge left the Lower Granites Dam fish collection facility.

During the 1987 season, barges transported 5,188,774 fish which accounted for 94.852 of the total fish transported. Of these, chinook, hatchery steelhead, wild steelhead, sockeye, and coho accounted for 2,409,664 (46.4%), 2,251,160 (43.4%), 527,176 (10.1%), 752 (0.01%), and 22 (<0.01%), respectively.

Of the total number of fish loaded into barges, 31.9% were directly loaded from the separator. This low percentage is largely a result of no barge being present at the juvenile fish facility. When a barge arrived at the facility in the late afternoon or evening and no COE personnel was on duty to install direct loading gear, the smolts were held in raceways until morning. Fish were also held in raceways when collection numbers were high. This was done because daily pound count fluctuations would have caused barge loading densities to increase above FTOT guidelines. Additionally, the juvenile fish facility at Little Goose Dam occasionally needed barge space, varying on a daily basis.

Transport policies could be improved to increase transport efficiency. Barges could be required to return to the facility promptly from April 26 through May 5 when additional barges were needed to transport fish. We feel the FTOT criteria of 1/2 pound per gallon for raceway loading may be detrimental to chinook smolts. Had additional barges been available, high fish densities occurring in raceways would have been avoided.

ORIFICES AND FISH COLLECTION GALLERY

Orifices in the fish collection gallery were cleared at least twice per day during the 1987 collection season. During peak collection periods, orifices were cleared four times per day. The 12-inch orifices never clogged during the entire season, while workers found the 8-inch orifices clogged throughout the season with small pieces of debris. These were cleared regularly to remove potential fish hazards (sticks, twigs and plastic) so that fish could move unharmed into the collection gallery. Minor water fluctuations occurred in the gallery due to generation load and forebay level changes, but no serious problems occurred.

Orifices, according to the O&M policy manual, were rotated every other day. Gatewells (bulkhead slots and fish-screen slots) were cleaned of debris once or twice a week if necessary. Deteriorating fish condition on April 18 and May 7 required trash racks to be raked. Trash racks were raked prior to the season and again on April 21 and 22.

FISH CONDITION

Even though the Snake River watershed experienced severe drought conditions, fish condition remained good throughout the entire juvenile outmigration with few exceptions. Fish condition did deteriorate progressively, especially in the latter season, due to increasing water temperatures and length of time spent in the Lower Granite pool. All species observed showed progressive signs of malnutrition from lack of a food source and prolonged delay in migration.

Chinook collected early in the season with fungus were identified by freeze-brands as originating from Rapid River Fish Hatchery in Idaho. Fungus normally occurred in the areas of the caudal peduncle and dorsal fins. As the season progressed, the incidence of fungus decreased. External signs of bacterial kidney disease increased during the middle of the season, but declined toward the end of May. This decline occurred because late hatchery releases of healthier fish diluted the general population existing in Lower Granite pool. This phenomenon was substantiated by freeze-brand observation in the daily collection sample.

Both wild and hatchery steelhead trout were in excellent condition during the early outmigration period. Fungus increased gradually to mid-season, then disappeared by early June. Only hardy, robust individuals survived migration through Lower Granite pool when flows dropped below 25 kcfs on June 25. The incidence of scattered and patchy descaled fish continued through the remainder of the season with little sign of fungus.

Throughout the season, raceway densities were held at safe levels; but during high fish collection (in excess of 300,000 per day), chinook mortalities increased drastically. We felt the larger steelhead increased stress on chinook under crowded conditions. On May 2, fish died so fast that screens began plugging up, which almost caused raceway flooding. Dead fish were then weighed by the pound instead of being counted by hand. Only during high collection was this considered a problem.

In 1987, scale regeneration was observed on large numbers of hatchery and wild steelhead. Scale regeneration has been observed before but never in this magnitude. We feel the severe 1987 drought conditions and resulting low flows allowed fish time to regenerate lost scales while holding in the Lower Granite pool. The first signs of

regeneration showed smolts with small new scales growing over previously descaled areas. Later on in the season, scale regeneration was so advanced that previously descaled areas were completely covered with new full-sized scales.

JUVENILE DESCALING

An attempt was made by IDFG personnel to sample 300 fish (100 hatchery steelhead, 100 wild steelhead, and 100 chinook) daily for descaling using standard sectionalized descaling methods. This was only accomplished on 39 of 126 days. In some instances, low sample sizes resulted in invalid descaling percentages. Descaling percentages remained low most of the season, changing slightly during fluctuating water flows.

Hatchery steelhead descaling rates averaged 1.581 in 1987 (Appendix 5). This represents a decrease from 4.71 in 1986. Hatchery steelhead showed a high amount of scattered and patchy descaling toward the end of the season. By mid-season, a large number of hatchery steelhead were observed regenerating scales on areas previously descaled. This phenomenon contributed to low descaling the rest of the season.

Wild steelhead descaling rates averaged 1.27% in 1987, the lowest of any species sampled, representing a decrease from 1.83% during 1986. Additionally, scattered and patchy descaling was low. Regeneration of wild steelhead scales was also seen.

Chinook descaling rates averaged 3.12% in 1987, decreasing from last year's average of 3.7%. Scattered and patchy descaling was moderate. Few chinook were observed with regenerated scales.

In instances where the sample size was low, daily descaling percentages were inaccurate. However, these percentages are used to calculate the weighted seasonal average.

Total facility mortality for the 1987 juvenile outmigration was 0.72% compared to 0.29% last year. Species mortality percentages were: chinook 1.17, hatchery steelhead 0.41, and wild steelhead 0.06.

In comparing 1986 with 1987, mortality increased from 0.20% to 0.72%, respectively. This is probably due to the severe drought conditions experienced in 1987. During peak collection periods, raceway densities were high, causing increased stress to smolts being held. Additionally, low flows increased the juvenile migrants' travel time through the Snake River and accompanying tributaries, causing fish condition to deteriorate.

We feel mortality estimates are inaccurate when taking into account that many mortalities are never recovered. In a hatchery environment, a large percentage of dead fish sink to the bottom of the raceway. A

similar situation occurs in the barges and trucks loaded at the juvenile fish facility. Although some dead fish are recovered as they are pushed along by the fish crowder and brought to the surface by recirculation currents, many are never recovered. These dead fish are then released into the pool and are not recorded. We realize it is impossible to retrieve all mortalities, but feel it is important to note that mortalities data may be biased.

SUBMERSIBLE TRAVELING SCREENS

The submersible traveling screens were installed on units 1-4 on March 3 and in units 5-6 on March 4. The first video inspection of the screens was done on April 22 and was continued on May 5. During the video inspections, no damage of the screens was discovered. Unlike 1986, the screens remained in the cycling mode of operation (on for 4 min. and off for 20 min.) for the entire smolt collection period. Because the average length of chinook never dipped below 115 mm, the screens were never put on a continuous run mode of operations.

MODIFICATIONS

Several modifications were made to the juvenile fish facility at Lower Granite Dam for the 1987 outmigration:

1. The two 1/4 hp chiller/aerator units in the reservoir of the recirculating anesthetic system were replaced by a single 1 hp unit.
2. Additional handrails were installed around the facility wherever needed. New steps were installed from the separator to the fish distribution flume at the head of the downstream set of raceways.
3. New Smith-Root counters with translucent tunnels were used.
4. The aluminum perforated plate was replaced in the separator hopper and over the porosity control gates.
5. Direct load lines were modified on the barge dock. Routing valves were installed so fish could be directed to alternate barge ports by simply moving a handle, allowing loading changes to be made quickly, easily, and safely.
6. White PVC pipe from the sample tank to the sampling room was replaced with semitransparent pipe so fish that held up in the tube could be easily detected and flushed out.

7. Raceway headscreens were extended to prevent fish from jumping behind. Seven additional raceway distribution boxes were built and installed to eliminate the need to move them from one raceway to another.
8. A new Cummins engine was installed on Barge No. 2817.
9. Noise was greatly reduced on the water eliminator from the separator.
10. Gratings in the powerhouse gallery were tacked down to the support frames.
11. Handrails on the two smaller barges were removed, and grating was installed over the holds.
12. The 24-hour data collection period was shifted to 0700-0700, coinciding with the 24-hour sampling period.

RESEARCH PROJECTS

Several research projects were conducted at Lower Granite Dam this year. A brief description of the projects, with preliminary results, is given below.

Evaluation of Fishway Designs for Downstream Passage of Spring Chinook and Steelhead Trout Smolts, 1987

The collection facility at Little Goose Dam for downstream migrating chinook and salmon and steelhead trout smolts is about to be rebuilt. The need for a bypass system carrying fish from the dam to the collection facility is necessary. To evaluate various fishway designs, three were tested at Lower Granite Dam: (1) a corrugated metal flume (CMF), (2) a 2 ft. x 2 ft. baffled flume (BF1), and (3) a 4 ft. x 4 ft. baffled flume (BF2).

The flumes were equipped with holding tanks for test fish at the head end and receiving tanks at the tail end. Fish were collected and transported to the holding tanks. When the fish had recovered from capture and handling, a control sample was taken from one holding tank (n-20 fish), and the fish from a second tank (n-20 fish) were released into the upper end of the flume. Fish entering the holding box at the tail end of the flume, were sampled to achieve the objectives. Any fish not traveling the full length of the flume was omitted from the data. The data will be analyzed by appropriate multiple-comparison tests. Results will then be reviewed and a flume type chosen for the Little Goose facility.

Bacterial Kidney Disease Study

The problem of Bacterial Kidney Disease (BKD) in spring chinook salmon is an important impediment to the successful restoration of this important race to the Snake River drainage. Chinook salmon smolts collected at Lower Granite Dam were sampled daily. A total of 1,525 chinook were sampled and sent to the lab for analysis with regards to BKD.

Transportation Evaluation

Numerous field transportation tests have been conducted at Snake and Columbia River dams. The research will evaluate the transportation benefits following years of extensive facility modifications and provide COE and fisheries managers with new data on which to base operational decisions for juvenile fish protection.

Chinook salmon and steelhead trout (hatchery and wild) were marked in order to study the benefits of fish transportation. Experimental marked groups were loaded onto trucks and barges and transported below Bonneville Dam and released. Because of the low flow year, no control groups were marked.

Hatchery steelhead trout were marked by right ventral fin clipping, freeze-branding, and coded-wire tagging. Wild steelhead trout were marked by right ventral and adipose fin clipping, freeze-branding, and coded-wire tagging. Chinook salmon were marked by adipose fin clipping, freeze-branding and coded-wire tagging. Only fish that appeared to be in good condition and had no previous marks or clips were used.

Brand and wire codes were changed every 5,000 and 4,250 fish during chinook salmon and steelhead trout marking, respectively. Every other day, 50 fish were held 48 hours for delayed mortality, brand quality, and coded-wire tag retention data. Tag loss for both chinook and steelhead was less than 1%.

Fish Guiding Efficiency of Submersible Traveling Screens at Lower Granite Dam, 1987

The primary objective at Lower Granite Dam was to compare fish guidance efficiency (FGE) obtained with a submersible traveling screen (STS) with a bar screen deflector (BSD) to FGE obtained with a STS and no BSD. Additionally, vertical distribution will provide an estimation of turbine passage depth distribution of juvenile salmonids.

FGE was tested from April 11 to May 7, 1987. During this period, tests were conducted a total of 21 nights.

Lower Granite Pool Survival Study, 1987

This study was conducted to estimate the survival rate of juvenile yearling chinook salmon traversing Lower Granite pool from a release site 16 miles above Asotin, Washington, to Lower Granite Dam.

Approximately 12,000 spring chinook salmon were pit-tagged from Rapid River Fish Hatchery near Riggins, Idaho. Fish were released 16 miles above Asotin (1,700 fish) into the turbines (700 fish) and the tailrace (600 fish) at Lower Granite Dam. Each release group was replicated three times over the course of the outmigration. In addition, a single group of pit-tagged fish (3,000) was released with the production release into Hells Canyon to provide timing information to the Fish Passage Center.

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APPENDICES

Appendix 1. Fish collection summary at Lower Granite Dam, 1987.

Date	Chinook	Hatchery steelhead	Wild steelhead	Coho	Sockeye	Total
03-26	22	0	0	0	0	22
03-27	0	0	0	0	0	0
03-28	44	0	45	0	0	89
03-29		0	45	0	10	144
03-30	89		33	0	0	122
03-31	100	0	55	0	0	155
04-01	89	0	11	0	0	100
04-02	155	11	44	0	0	210
04-03	123	22	45	0	0	190
04-04	198	44	77	0	0	319
04-05	430	11	44	0	0	485
04-06	1230	177	44	0	11	1462
04-07	2630	633	222	0	0	3485
04-08	4810	1733	290	0	0	6833
04-09	5641	1914	283	0	0	7838
04-10	6893	1965	255	0	0	9113
04-11	16693	1918	399	0	0	19010
04-12	16402	1667	517	0	0	18586
04-13	15502	2584	801	0	0	18887
04-14	26480	2165	756	0	9	29410
04-15	18318	1460	933	0	21	20732
04-16	46616	1827	928	0	0	49371
04-17	40794	897	600	0	0	42291
04-18	81474	1458	846	0	0	83778
04-19	71655	2135	1086	0	30	74906
04-20	86284	2685	1751	0	0	90720
04-21	72584	3529	1929	0	39	78081
04-22	104335	6529	2263	0	22	113149
04-23	72693	3394	3030	0	0	79117
04-24	103779	3930	3308	0	0	111017
04-25	104585	8550	7800	0	0	120935
04-26	147755	42445	10581	0	0	20078
04-27	182878	69392	14316	0	0	266586
04-28	117826	67502	12334	0	0	197662
04-29	162457	101977	18444	0	0	282878
04-30	144225	115876	34898	0	0	294999
05-01	15006	116340	35052	0	0	301398
05-02	180279	238702	67374	0	97	486452
05-03	96604	180366	39288	0	63	316321
05-04	104774	198397	56505	0	0	359676
05-05	28397	122210	26046	0	53	176706
05-06	12260	76454	16161	0	0	104875
05-07	9425	92359	21698	0	9	12349
05-08	12559	78961	14532	0	21	106073
05-09	14953	67935	16514	0	20	99422
05-10	12347	51590	8186	0	0	72123

Appendix 1. Continued.

Date	Chinook	Hatchery steelhead	Wild steelhead	Coho	Sockeye	Total
05-11	10579	47347	11664	0	7	69597
05-12	16772	74505	14778	0	32	106087
05-13	23968	61757	13949	0	30	99704
05-14	20935	93381	16512	0	13	130841
05-15	10400	46334	4782	12	12	61540
05-16	11122	35431	6961	0	32	53546
05-17	5997	35732	5194	0	0	46923
05-18	5907-	32281	5289	0	22	43499
05-19	6260	19446	3162	0	35	28903
05-20	5580	11254	2160	10	13	19017
05-21	4028	15252	2530	0	35	21845
05-22	2513	10665	1714	0	15	14907
05-23	4705	13441	2430	0	14	20590
05-24	3096	6715	1077	0	11	10899
05-25	2826	4227	718	0	10	7781
05-26	2665	2898	466	0	11	6040
05-27	4152	6759	844	0	16	11771
05-28	2998	4329	533	0	33	7893
05-29	2419	9092	2087	0	0	13598
05-30	3407	14594	2387	0	0	20388
05-31	3909	28966	6062	0	0	38937
06-01	2219	6781	1365	0	33	10398
06-02	2642	3975	1233	0	0	7850
06-03	2220	2853	623	0	0	5696
06-04	2552	4617	1177	0	0	8346
06-05	2153	4317	755	0	0	7225
06-06	1498	2508	599	0	0	4605
06-07	1520	2718	422	0	0	4660
06-08	3163	12664	2542	0	0	18369
06-09	2330	7259	1266	0	0	10855
06-10	2066	3697	655	0	0	6418
06-11	1787	3996	777	0	0	6560
06-12	2452	6580	788	0	0	9820
06-13	5095	6782	1076	0	12	12965
06-14	2275	10433	1088	0	0	13796
06-15	2492	19946	1875	0	0	24313
06-16	1400	7101	967	0	0	9468
06-17	1129	6154	867	0	0	8150
06-18	1798	3573	477	0	0	5848
06-19	976	2130	311	0	0	3417
06-20	1472	2783	287	0	0	4542
06-21	1893	6597	518	0	0	9008
06-22	722	1288	111	0	0	2121
06-23	688	2197	189	0	0	3074
06-24	543	1964	56	0	0	2563
06-25	877	3386	155	0	0	4418
06-26	1776	4402	123	0	0	6301

Appendix 1. Continued.

Date	Chinook	Hatchery steelhead	Wild steelhead	Coho	Sockeye	Total
06-27	1864	6370	267	0	0	8501
06-28	1920	2842	144	0	0	4906
06-29	2176	4773	243	0	0	7192
06-30	2054	4496	238	0	0	6738
07-01	1309	4816	89	0	0	6214
07-02	1154	5970	233	0	0	7357
07-03	1188	10787	555	0	0	12530
07-04	821	6125	533	0	0	7479
07-05	477	2376	145	0	0	2998
07-06	344	2629	310	0	0	3283
07-07	333	1098	89	0	0	1520
07-08	288	809	189	0	0	1286
07-09	288	930	78	0	0	1296
07-10	211	1390	122	0	0	1723
07-11	210	763	89	0	0	1062
07-12	122	909	44	0	0	1075
07-13	155	775	77	0	0	1007
07-14	233	2509	133	0	0	2875
07-15	189	1821	89	0	0	2099
07-16	78	663	55	0	0	796
07-17	88	796	44	0	0	928
07-18	55	342	66	0	0	463
07-19	12	132	21	0	0	165
07-20	67	462	77	0	0	606
07-21	55	519	44	0	0	618
07-22	78	967	155	0	0	1200
07-23	11	808	89	0	0	908
07-24	77	1331	132	0	0	1540
07-25	33	2040	100	0	0	2173
07-26	89	1820	155	0	0	2064
07-27	44	1320	145	0	0	1509
07-28	44	1528	144	0	0	1716
07-29	33	576	44	0	0	653
07-30	11	454	56	0	0	521
07-31	66	242	33	0	0	341
Total	2497635	2463039	550947	22	791	5512434

Appendix 2. Truck transportation summary for fish collected at Lower Granite Dam, 1987.

Date	Chinook	Hatchery steelhead	Wild steelhead	Coho	Sockeye	Total
03-29		155	0	90	0	10 255
03-30		0	0	0	0	0 0
03-31		133	0	7	0	0 275
04-01		0	0	0	0	0 0
04-02		238	11	54	0	0 303
04-03		0	0	0	0	0 0
04-04		0	0	0	0	0 0
04-05		0	0	0	0	0 0
04-06		1963	254	210	0	11 2438
05-07		1013	10260	2415	0	1 13689
06-05		2139	4281	754	0	0 7174
06-06		0	0	0	0	0 0
06-07		2970	5099	1020	0	0 9089
06-08		3135	12605	2541	0	0 18281
06-09		2302	7218	1266	0	0 10786
06-10		2017	3636	649	0	0 6302
06-11		1712	3929	774	0	0 6415
06-12		2353	6491	788	0	0 9632
06-13		4926	6639	1074	0	12 12651
06-14		2095	10125	1080	0	0 13300
06-15		2384	19340	1869	0	0 23593
06-16		1262	6515	936	0	0 8713
06-17		1034	5853	860	0	0 7747
06-18		1671	3162	462	0	0 5295
06-19		902	1973	294	0	0 3169
06-20		0	0	0	0	0 0
06-21		3175	8891	775	0	0 12841
06-22		0	0	0	0	0 0
06-23		1261	3195	270	0	0 4726
06-24		0	0	0	0	0 0
06-25		1312	5137	201	0	0 6650
06-26		0	0	0	0	0 0
06-27		3444	10481	372	0	0 14297
06-28		0	0	0	0	0 0
06-29		3952	7267	363	0	0 11582
06-30		0	0	0	0	0 0
07-01		3213	8948	259	0	0 12420
07-02		0	0	0	0	0 0
07-03		2167	16277	770	0	0 19214
07-04		0	0	0	0	0 0
07-05		1138	8059	658	0	0 9855
07-06		0	0	0	0	0 0
07-07		602	3487	393	0	0 4482
07-08		0	0	0	0	0 0
07-09		477	1552	263	0	0 2292
07-10		0	0	0	0	0 0

Appendix 2. Continued.

Date	Chinook	Hatchery steelhead	Wild steelhead	Coho	Sockeye	Total
07-11		380	2035	211	0	2626
07-12		0	0	0	0	0
07-13		216	1590	121	0	1927
07-14		0	0	0	0	0
07-15		386	4076	219	0	4681
07-16		0	0	0	0	0
07-17		137	1368	99	0	1604
07-18		0	0	0	0	0
07-19		49	439	87	0	575
07-20		0	0	0	0	0
07-21		112	916	117	0	1145
07-22		0	0	0	0	0
07-23		83	1682	238	0	2003
07-24		0	0	0	0	0
07-25		102	3246	226	0	3574
07-26		0	0	0	0	0
07-27		125	2953	294	0	3372
07-28		0	0	0	0	0
07-29		69	1972	183	0	2224
07-30		0	0	0	0	0
07-31		72	612	88	0	772
Totals	56931	201574	23430	0	34	281969

Appendix 3. Barge transportation summary for fish collected at Lower Granite Dam, 1987.

Date	Chinook	Hatchery steelhead	Wild steelhead	Coho	Sockeye	Total
04-10	19803	6231	1049	0	0	27083
04-11	0	0	0	0	0	0
04-12	32996	3577	915	0		37488
04-13	0	0	0	0	0	0
04-14	41706	4737	1557	0	9	48009
04-15	0	0	0	0	0	0
04-16	64716	3278	1861	0	21	69876
04-17	0	0	0	0	0	0
04-18	121765	2346	1445	0	0	12555
04-19	0	0	0	0	0	0
04-20	157295	4811	2837	0	30	16497
04-21	0	0	0	0	0	0
04-22	176611	10048	4192	0	61	190912
04-23	0	0	0	0	0	0
04-24	176157	7311	6336	0	0	18980
04-25	0	0	0	0	0	0
04-26	251342	50946	18379	0	0	32066
04-27	182309	69370	14316	0	0	26599
04-28	115177	67468	12334	0	0	19497
04-29	161606	101940	18443	0	0	28198
04-30	143159	115832	34898	0	0	29388
05-01	146623	116251	35052	0	0	297926
05-02	176727	238614	67373	0	97	482811
05-03	88222	180282	39288	0	63	307855
05-04	102298	198319	56505	0	0	357122
05-05	27793	122164	26046	0	53	176056
05-06	12194	76423	16160	0	0	104777
05-07	8361	82034	19283	0	8	10968
05-08	12519	78904	14532	0	21	10597
05-09	14921	67880	16514	0	20	99335
05-10	12308	51553	8185	0	0	72046
05-11	10545	47314	11663	0	7	69529
05-12	16715	74434	14778	0	32	10595
05-13	23923	61649	13948	0	30	99550
05-14	20867	93275	16511	0	13	13066
05-15	10368	46282	4782	12	12	61456
05-16	11081	35394	6961	0	32	53468
05-17	5961	35673	5194	0	0	46828
05-18	5867	32205	5289	0	22	43383
05-19	6231	19389	3157	0	34	28811
05-20	5548	11229	2159	10	13	18959
05-21	4001	15205	2528	0	35	21769
05-22	2477	10617	1713	0	14	14821
05-23	4675	13336	2426	0	13	20450
05-24	0	0	0	0	0	0
05-25	5848	10698	1794	0	19	18359

Appendix 3. Continued.

Date	Chinook	Hatchery steelhead	Wild steelhead	Coho	Sockeye	Total
05-26		0	0	0	0	0
05-27	6745	9510	1309	0	27	17591
05-28		0	0	0	0	0
05-29	5342	13253	2617	0	33	21245
05-30		0	0	0	0	0
05-31	7280	43405	8449	0	0	59134
06-01		0	0	0	0	0
06-02	4842	10652	2598	0	33	18125
06-03		0	0	0	0	0
06-04	4740	7321	1800	0	0	13861
Total	2409664	2251160	527176	22	752	5188774

Appendix 4. Percent daily species composition of fish collected at Lower Granite Dam, 1987.

Date	% chinook	% hatchery steelhead	% wild steelhead	% sockeye	% coho
03-26	100	0	0	0	0
03-27	0	0	0	0	0
03-28	50	0	50	0	0
03-29	62	0	31	7	0
03-30	72.73	0	27.27	0	0
03-31	64.28	0	35.72	0	0
04-01	88.89	0	11.11	0	0
04-02	73.69	5.26	21.05	0	0
04-03	64.70	11.76	23.54	0	0
04-04	62.07	13.79	24.14	0	0
04-05	88.64	2.27	9.09	0	0
04-06	84.10	12.12	3.03	0.75	0
04-07	75.48	18.15	6.37	0	0
04-08	70.40	25.36	4.24	0	0
04-09	71.97	24.42	3.61	0	0
04-10	75.64	21.56	2.80	0	0
04-11	87.81	10.09	2.10	0	0
04-12	88.25	8.97	2.78	0	0
04-13	82.08	13.68	4.24	0	0
04-14	90.04	7.36	2.57	0.03	0
04-15	88.35	7.04	4.50	0.10	0
04-16	94.42	3.70	1.88	0	0
04-17	96.46	2.12	1.42	0	0
04-18	97.25	1.74	1.01	0	0
04-19	95.66	2.85	1.45	0.04	0
04-20	95.11	2.96	1.93	0	0
04-21	92.96	4.52	2.47	0.05	0
04-22	92.21	5.77	2.00	0.02	0
04-23	91.88	4.29	3.83	0	0
04-24	93.48	3.54	2.98	0	0
04-25	86.48	7.07	6.45	0	0
04-26	73.59	21.14	5.27	0	0
04-27	68.60	26.03	5.37	0	0
04-28	59.61	34.15	6.24	0	0
04-29	57.43	36.05	6.52	0	0
04-30	48.89	39.28	11.83	0	0
05-01	49.77	38.60	11.63	0	0
05-02	37.06	49.07	13.85	0.02	0
05-03	30.54	57.02	12.42	0.02	0
05-04	29.13	55.16	15.71	0	0
05-05	16.07	69.16	14.74	0.03	0
05-06	11.69	72.90	15.41	0	0
05-07	7.63	74.78	17.57	0.72	0
05-08	11.84	74.44	13.70	0.02	0
05-09	15.04	68.33	16.61	0.02	0
05-10	17.12	71.53	11.35	0	0

Appendix 4. Continued.

Date	% chinook	% hatchery steelhead	% wild steelhead	% sockeye	% coho
05-11	15.20	68.03	16.76	0.01	0
05-12	15.81	70.23	13.93	0.03	0
05-13	24.04	61.94	13.99	0.03	0
05-14	16.00	71.37	12.62	0.01	0
05-15	16.90	75.29	7.77	0.02	0.02
05-16	20.77	66.17	13.00	0.06	0
05-17	12.78	76.15	11.07	0	0
05-18	13.58	74.21	12.16	0.05	0
05-19	21.66	67.28	10.94	0.12	0
05-20	29.34	59.18	11.36	0.07	0.05
05-21	18.44	69.82	11.58	0.16	0
05-22	16.86	71.54	11.50	0.10	0
05-23	22.85	65.28	11.80	0.07	0
05-24	28.41	61.61	9.88	0.10	0
05-25	36.31	54.33	9.23	0.13	0
05-26	44.12	47.98	7.72	0.18	0
05-27	35.27	57.42	7.17	0.14	0
05-28	37.98	54.85	6.75	0.42	0
05-29	17.79	66.86	15.35	0	0
05-30	16.71	71.58	11.71	0	0
05-31	10.04	74.39	15.57	0	0
06-01	21.34	65.21	13.13	0.32	0
06-02	33.66	50.64	15.70	0	0
06-03	38.98	50.10	10.92	0	0
06-04	30.58	55.32	14.10	0	0
06-05	29.80	59.75	10.45	0	0
06-06	32.53	54.46	13.01	0	0
06-07	32.62	58.33	9.05	0	0
06-08	17.22	68.94	13.84	0	0
06-09	21.47	66.87	11.66	0	0
06-10	32.18	57.61	10.21	0	0
06-11	27.24	60.91	11.85	0	0
06-12	24.97	67.01	8.02	0	0
06-13	39.30	52.31	8.30	0.09	0
06-14	16.49	75.62	7.89	0	0
06-15	10.25	82.04	7.71	0	0
06-16	14.79	75.00	10.21	0	0
06-17	13.85	75.51	10.64	0	0
06-18	30.74	61.10	8.16	0	0
06-19	28.57	62.34	9.09	0	0
06-20	32.40	61.27	6.33	0	0
06-21	21.01	73.24	5.75	0	0
06-22	34.03	60.73	5.24	0	0
06-23	22.38	71.48	6.14	0	0
06-24	21.21	76.62	2.17	0	0
06-25	19.85	76.63	3.52	0	0
06-26	28.19	69.86	1.95	0	0

Appendix 4. Continued.

Date	% chinook	% hatchery steelhead	% wild steelhead	% sockeye	% coho
06-27	21.93	74.93	3.14	0	0
06-28	39.14	57.92	2.94	0	0
06-29	30.25	66.36	3.39	0	0
06-30	30.48	66.72	2.80	0	0
07-01	21.07	77.50	1.43	0	0
07-02	15.69	81.15	3.16	0	0
07-03	9.48	86.09	4.43	0	0
07-04	10.98	81.90	7.12	0	0
07-05	15.92	79.26	4.82	0	0
07-06	10.47	80.07	9.46	0	0
07-07	21.90	72.26	5.84	0	0
07-08	22.41	62.93	14.66	0	0
07-09	22.22	71.79	5.99	0	0
07-10	12.26	80.64	7.10	0	0
07-11	19.79	71.87	8.34	0	0
07-12	11.34	84.54	4.12	0	0
07-13	15.38	76.92	7.70	0	0
07-14	8.11	87.26	4.63	0	0
07-15	8.99	86.77	4.24	0	0
07-16	9.72	83.33	6.95	0	0
07-17	9.52	85.71	4.77	0	0
07-18	11.92	73.80	14.28	0	0
07-19	7.00	80.00	13.00	0	0
07-20	11.11	76.19	12.70	0	0
07-21	8.93	83.93	7.14	0	0
07-22	6.49	80.55	12.96	0	0
07-23	1.22	89.02	9.76	0	0
07-24	5.00	86.43	8.57	0	0
07-25	1.54	93.87	4.59	0	0
07-26	4.3	88.17	7.53	0	0
07-27	2.94	87.50	9.56	0	0
07-28	2.58	89.03	8.39	0	0
07-29	5.09	88.13	6.78	0	0
07-30	2.13	87.23	10.64	0	0
07-31	19.35	70.96	9.69	0	0

Appendix 5. Daily descaling rates of chinook, hatchery steelhead, and wild steelhead collected at Lower Granite Dam, 1987.

Date	% chinook	% hatchery steelhead	% wild steelhead
03-28	25	0	0
03-29	25	0	0
03-30	25	0	0
03-31	11	0	0
04-01	12.5	0	0
04-02	17	0	25
04-03	0	0	0
04-04	5.5	0	0
04-05	2.6	0	0
04-06	*5	0	0
04-07	2	0	0
04-08	4	*0	5.2
04-09	2	2.2	0
04-10	2	0	0
04-11	2	1	3.1
04-12	4	0	0
04-13	2	1	0
04-14	2	2	0
04-15	1	3.2	2.4
04-16+	3	1	1
04-17	2	3.8	0
04-18+	9	3	0
04-19	5	2.7	0
04-20+	4	4	1
04-21	2	2	3.7
04-22+	0	3	*0
04-23	1	1.35	1.09
04-24+	1	2	1
04-25+	1	4	1
04-26+	6	2	2
04-27+	4	4	0
04-28+	5	1	1
04-29+	5	0	1
04-30+	8	4	3
05-01+	3	3	1
05-02+	5	.5	.5
05-03+	3	3	0
05-04+	3	4	0
05-05+	5	3	1
05-06+	8	3	2
05-07+	12	6	3
05-08+	3	6	4
05-09+	4	4	1
05-10	3	6.89	3.57
05-11+	2	3	2
05-12+	4	4	9

Appendix 5. Continued.

Date	% chinook	% hatchery steelhead	% wild steelhead
05-13+	2	2	2
05-14+	4	2	2
05-15+	1	2	0
05-16+	3	1	4
05-17	2	3	3.6
05-18+	2	4	0
05-19	3	4.5	2.9
05-20+	2	4	2
05-21	3.5	0	0
05-22+	1	2	1
05-23+	1	1	1
05-24	1	0	0
05-25+	1	0	0
05-26	1.2	3.03	2.85
05-27+	1	2	3
05-28	2	2	0
05-29+	1	3	1
05-30+	3	1	1
05-31+	2	3	2
06-01	1	2.4	4
06-02	4	0	0
06-03	1	3	0
06-04+	3	1	1
06-05	2.22	3	1.64
06-06	2.3	1.8	0
06-07	1	1.25	0
06-08+	3	1	0
06-09+	5	1	0
06-10	4	1	0
06-11	3	3	1.4
06-12	6	1	2.9
06-13	5	1	0
06-14	6	2	1.04
06-15+	5	0	0
06-16	5.4	0	0
06-17	2.43	1	0
06-18	2	0	0
06-19	0	0	0
06-20	2	0	0
06-21	4	0	0
06-22	5.45	5.38	0
06-23	5.26	2	0
06-24	2.7	0	0
06-25	3.27	0	0
06-26	2	0	0
06-27	3	0	4.3
06-28	2	0	0

Appendix 5. Continued.

Date	% chinook	% hatchery steelhead	% wild steelhead
06-29	2	0	0
06-30	2	0	0
07-01	0	0	0
07-02	0	0	0
07-03	0	1	0
07-04	1.49	1	0
07-05	5.7	0	0
07-06	7.1	0	0
07-07	0	0	0
07-08	5.6	0	0
07-09	0	0	0
07-10	0	2	0
07-11	0	0	0
07-12	0	0	0
07-13	9	0	0
07-14	0	1	0
07-15	0	0	0
07-16	0	0	0
07-17	0	1.47	0
07-18	0	0	0
07-19	0	0	0
07-20	0	2.22	0
07-21	0	0	0
07-22	0	0	0
07-23	0	1.39	0
07-24	0	1	0
07-25	0	0	0
07-26	0	1	0
07-27	0	1.09	0
07-28	0	1	0
07-29	0	0	0
07-30	0	0	0
07-31	0	0	0

*represents the first day one hundred fish were sampled.

+represents days that 100 fish in each category were sampled.

Appendix 6. Average lengths of chinook and steelhead smolts collected at
Lower Granite Dam, 1987.

Date	Chinook	Steelhead
March 29	164	
30		194
31	¹ 51	
April 01		162
02		
03		179
04	132	
05		194
06	135	
07		214
08	139	
09		222
10	141	
11		212
12	134	
13		210
14	138	
15		209
16	141	
17		207
18	145	
19		207
20	136	
21		216
22	135	
23		206
24	138	
25		208
26	133	
27		217
28	130	
29		213
30	133	
May 01		213
02	126	
03		211
04	126	
05		207
06	120	
07		214
08	125	
09		214
10	121	
11		217
12	121	
13		216

Appendix 6. Continued.

Date		Chinook	Steelhead
	14	117	
	15		212
	16	121	
	17		200
	18	120	
	19		207
	20	121	
	21		199
	22	118	
	23		205
	24	123	
	25		209
	26	123	
	27		203
	28	117	
	29		202
	30	118	
	31		216
June	01	116	
	02		192
	03	118	
	04		210
	05	119	
	06		220
	07	122	
	08		214
	09	119	
	10		220
	11	122	
	12		228
	13	122	
	14		218
	15	120	
	16		228
	17	119	
	18		230
	19	117	
	20		234
	21	116	
	22		234
	23	117	
	24		245
	25	118	
	26		242
	27	121	
	28		241
	29	121	
	30		238
July	01	121	

Appendix 6. Continued.

Date	Chinook	Steelhead
02		240
03	122	
04		244
05	124	
06		237
07	122	
08		235
09	120	
10		242
11	119	
12		239
13	119	
14		241
15	125	
16		241
17	129	
18		226
19	118	
20		239
21	116	
22		230
23	170	
24		238
25	119	
26		232
27	121	
28		239
29	138	
30		228
31	130	

Submitted by:

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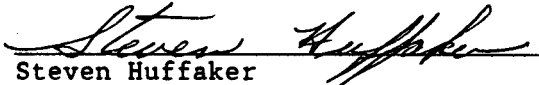
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